AERIAL DISPLAY IN THE LESSER FLORICAN

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(With four text-figures)

The aerial display of the lesser florican, an endangered bustard endemic to the Indian subcontinent is described. The changes in display patterns, an increase in site specificity of display, has been correlated to height of grass and increased rates of display. The preference for males to display in cloudy and cool conditions has been quantified.

Introduction

Aerial displays have been described in several species of birds (e.g. Storor 1940, Van Tyne and Berger 1959, Sutton 1981). Courtship displays in the bustard group include aerial displays which are performed by the smaller members, and are of two kinds. One of these is a display leap or jump and is present in the smallest members of the group, the little bustard *Tetrax tetrax* (Shulz 1985) and the lesser florican *Sypheotides indica* (Dharmakumarsinhji 1950, Ridley *et al.* 1985). The other is a display flight and is seen in small African bustards such as the black bellied *Eupodotis melanogaster,* buff crested *Eupodotis ruficrista,* and black *Eupodotis afra* (Johnsgard 1991), and in the Bengal Florican *Houbaropsis bengalensis* (Narayan and Rosalind 1988).

The lesser florican is an endangered endemic bustard of the Indian subcontinent. Its breeding system has been defined as the dispersed lek (Sankaran, in press), and it breeds during the southwest monsoon (Jerdon 1864, Dharmakumarsinhji 1950, Ali and Ripley 1969). During this period, the species exhibits a nomadic movement into Gujarat, eastern Rajasthan, and western Madhya Pradesh, where it congregates in areas of good rainfall. The primary breeding habitat is grasslands, almost devoid of trees which are generally of the *Sehima nervosum - Chrysopogon fulvus* type.

An important component in the understanding of a species breeding behaviour, is a knowledge of the displays that are performed in connection with breeding. Considerable literature is available on the general behaviour of the lesser florican as it was a popular game bird (e.g. Jerdon 1864, Baker 1921), its displays have been described (Dharmakumarsinhji 1950), and quantified (Ridley *et al.* 1985). Two displays related to breeding have been described in the male lesser florican ((Dharmakumarsinhji 1950). Aerial (jumping) displays are performed irrespective of the presence or absence of females or rival males, and probably serve both functions of attracting females and signalling territory possession. The second display is a pre-copulatory one, and is directed towards and performed only in the presence of females. In this paper, I quantitatively describe and discuss the aerial displays in the lesser florican with respect to temporal variations in aerial display patterns in the breeding season and the influence of weather on display rates.

Study area

I studied the lesser florican at three main grassland sites. The majority of the data was collected at the Naulakha grassland within the Sailana Kharmor Sanctuary in Ratlam district, Madhya Pradesh. Livestock are grazed in the Naulakha grassland for the first few weeks of the monsoon after which grazing is stopped. In 1988, the lesser florican was studied at the Rampura-Movalia-Kalitalai grasslands near Dohad in Panchmahal district, Gujarat. No grazing is permitted in the Rampura grassland.

Methods

The study extended over 400 days between July 16 and October 6, 1985; June 22 and October

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10, 1986; June 16 and October 1, 1987; June 24 and October 6, 1988. This study is based on direct observations of unmarked male lesser florican. Behavioural observations conformed to the focal animal sampling method (Altmann 1974). There were two principal methods of data collection. In 1985 and 1986, a lesser florican was located at dawn, and continuously observed until noon. The following day, a male was located at noon (if territorial, the same territory as on the previous day) and observed until dusk. Changes in activity to the nearest minute, and the total number of jumps in a five minute period were noted. This was modified in 1988, and observations were made from dawn to 12 noon and from 1400 hours to dusk. Males were observed for 20 continuous minutes, followed by a 10 minute interval. During the observation period, the time of every jump and change in activity was recorded to the nearest second. This method was found superior as the lesser florican is very active and can perform display leaps as rapidly as once every 25 seconds.

Weather data recorded during observations included temperature recorded in the shade every half hour at the observation point. Cloud cover was ranked as 0-25, 26-50, 51-75 and 75-100% of the sky. Similarly, rainfall was ranked as light drizzle, moderate drizzle and rain, and wind into light, medium and strong. Every change in the weather condition was noted to the nearest second.

Mean weekly grass height was calculated from sites at a minimum of 30 randomly selected points where maximum grass length was measured. Each study area had about five such sampling sites. Additionally, grass height at lesser florican 'jumping spots' was measured at 0, 1, 5, 10 and 25 m along North, South, East and West axis, with the jumping spot being the point of their bisection.

Statistical analyses were done on computer using Lotus 123 and Systat following guidelines laid down by Fowler and Cohen (1986).

Results

Description of the Aerial Display: The aerial display of the lesser florican is a vertical 'jump' (Fig. 1). The display is preceded by the bird standing, with its neck and head craned up, shuffling or stamping its feet. The white feathers of the throat and chin are erected and appear in some large males as a sort of white 'bib' and the neck feathers may be slightly fluffed up. The male abruptly faces the wind, retracts its head, crouches and leaps into the air by flexing its legs. Take off is followed by about 10 or more very rapid wing beats, which enables the male to reach a height of about 1.5 - 2 m, vertically above the spot of take off, the height being determined by the surrounding vegetation. During the ascent, the head is arched back, the neck feathers are slightly fluffed, and the auricular plumes are partly thrown forward. On reaching the peak of the ascent, the male drops back to the ground with its wings held partly closed and kept away from the body, and the legs are paddled a few times for balance. The bird crouches on landing, and then gradually raises itself up until fully erect, scanning the grassland around before performing the next display leap. All display leaps are performed into the wind, and on the few occasions when a male displayed at an angle to the wind it was invariably pushed off balance.

Each display jump lasts on average one second (min. = 0.8 s, max. = 1.1 s). During the peak of the breeding season, a male may spend 70 - 80% of the day in performing aerial display and related activities. The mean inter display leap duration is 40.23 seconds (SD = 40.06 s, max. = 613 s, min. = 4 s, n = 2396). Time lag between displays varies to some extent, depending on the degree of spot specificity and the weather conditions. The period in between display leaps is spent either in walking or foraging or standing and looking around.

Auditory signals of the Display Leap: The display jump is accompanied by a loud rattling or clapping auditory signal. This sound lasts about 0.4 to 0.5 seconds and is produced only during the ascent of the display flight. The sound consists of 7 or 8 individual sounds all similar in pitch and intensity (from sonograms; not presented here). This auditory signal of the display leap is made by the wings and is not a vocalization or produced by the clicking of the tongue as has been suggested by others

(Dharmakumarsinhji 1950, Osborne *et al.* 1984, Ridley *et al.* 1985). To produce this sound, the wings of the males have specialized pointed primaries which are not present in the female (Table 1). The exact mechanism by which this auditory signal is produced from the pointed primaries is not known. (The pointed primaries are present in non-breeding and sub-adult males, and are the final diagnostic difference between males and females).

Towards the peak of the breeding season, when males fly into their territories, they often land in the typical display flight pattern, with arched neck and head. When flushed, males often take to flight as in the display leap, before easing into regular flight. In both cases the auditory signal may be emitted.

Display Patterns: The breeding season of the lesser florican can be broadly classified into pre-territorial and territorial periods. The territorial period occupies most of the breeding season (1985: 42 of 71 days; 1986: 66 of 101 days) and can be classified into early, peak and end territorial periods. Within the territorial period, there are two patterns in display leaps. Spot specific display was when birds displayed continuously from a single spot without moving between jumps. Non-spot specific display was when the bird moved between jumps and when consecutive jumps were not performed from the same spot.

After arrival and until the establishment of territories (pre-territorial period), males are not site specific and spend most of the day foraging (Fig. 2). Males display occasionally but inconsistently. Towards the end of the pre-territorial phase, display becomes consistent with some degree of site specificity. Initially, after the establishment of territories, the major diurnal activity is 'Non-spot specific display'(NSS). The males spend most of their time foraging, constantly interrupting their foraging with display leaps. 'Spot specific display' (SSD) is relatively low during this period (Fig. 2). As the season progresses, NSS becomes less and SSD soon becomes the major diurnal activity.

This pattern varied between grassland sites, and between years, due to the effects of varying rainfall and grazing pressures. For instance, at the ungrazed Rampura grassland, the pre-territorial

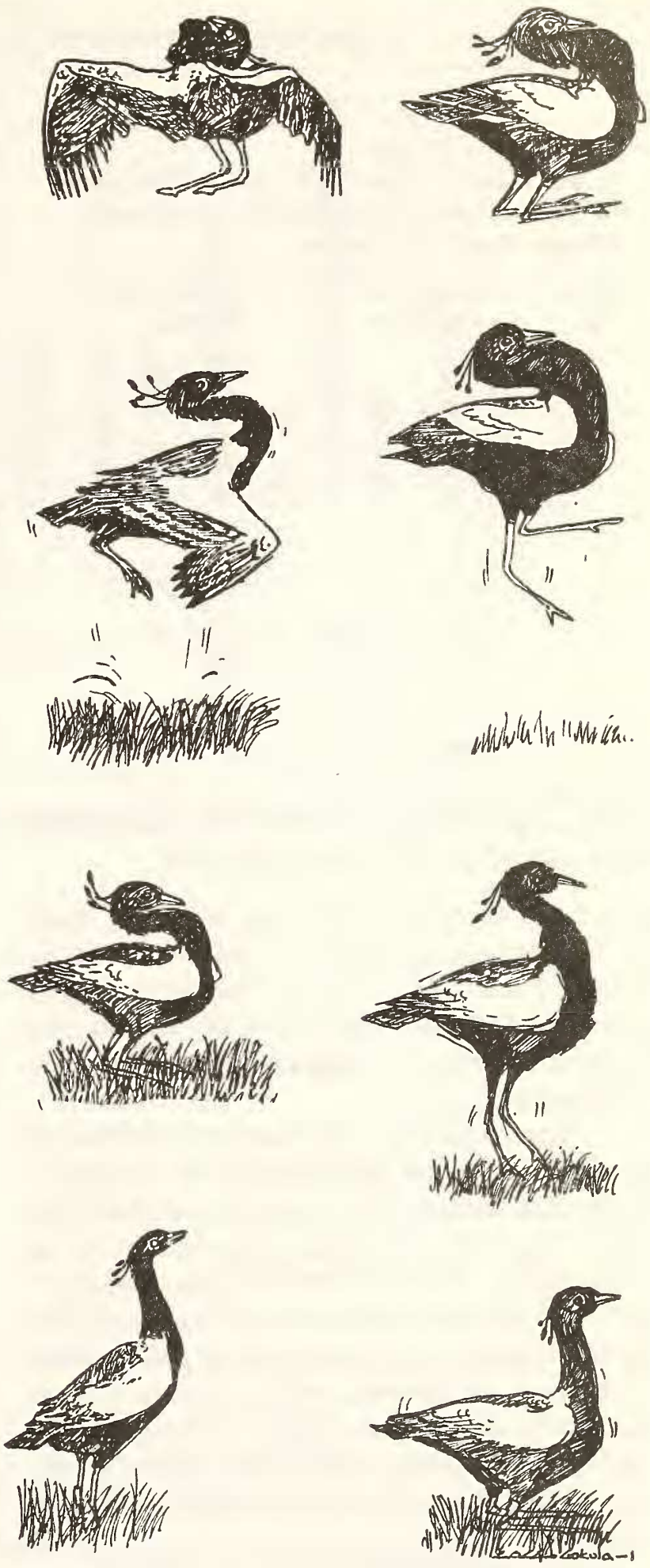


Fig. 1. Aerial display of the lesser florican.

TABLE 1
PRIMARY FEATHERS ON THE WINGS OF THE LESSER FLORICAN

Male			Female		
Wing length = 195 mm 11 primaries; overall narrow & pointed. First primary normal; Eleventh primary minute; outer primaries narroewr than inner primaries.			Wing length = 233 mm 11 primaries; overall slightly narrow. Primaries 1 to 5 normal; Primary 6 slightly narrowed; 7 to 10 distinctly tapered; Outer primaries narrower than inner.		
Prim. Nos.	Length (mm) of Notched Part	Width (mm) of Notched Part (at middle)	Prim. Nos.	Length (mm) of Notched Part	Width (mm) of Notched Part (at middle)
1	normal	-	1	normal	-
2*	46.0	8.3	2	normal	-
3	45.5	7.7	3	normal	-
4	51.1	7.7	4	normal	-
5	62.7	7.2	5	normal	-
6	56.7	6.7	6*	45.5	12.5
7	55.5	4.4	7	50.5	10.0
8	54.4	4.4	8	45.5	9.5
9	52.8	3.8	9	52.2	7.5
10	51.0	2.9	10	53.3	5.5
11	minute	-	11	minute	-

* Notch not distinctive.
(Data from one skin each of male and female from the BNHS collection For description of the pointed primaries in males see Jerdon 1864, Baker 1921, Ali and Ripley 1969).

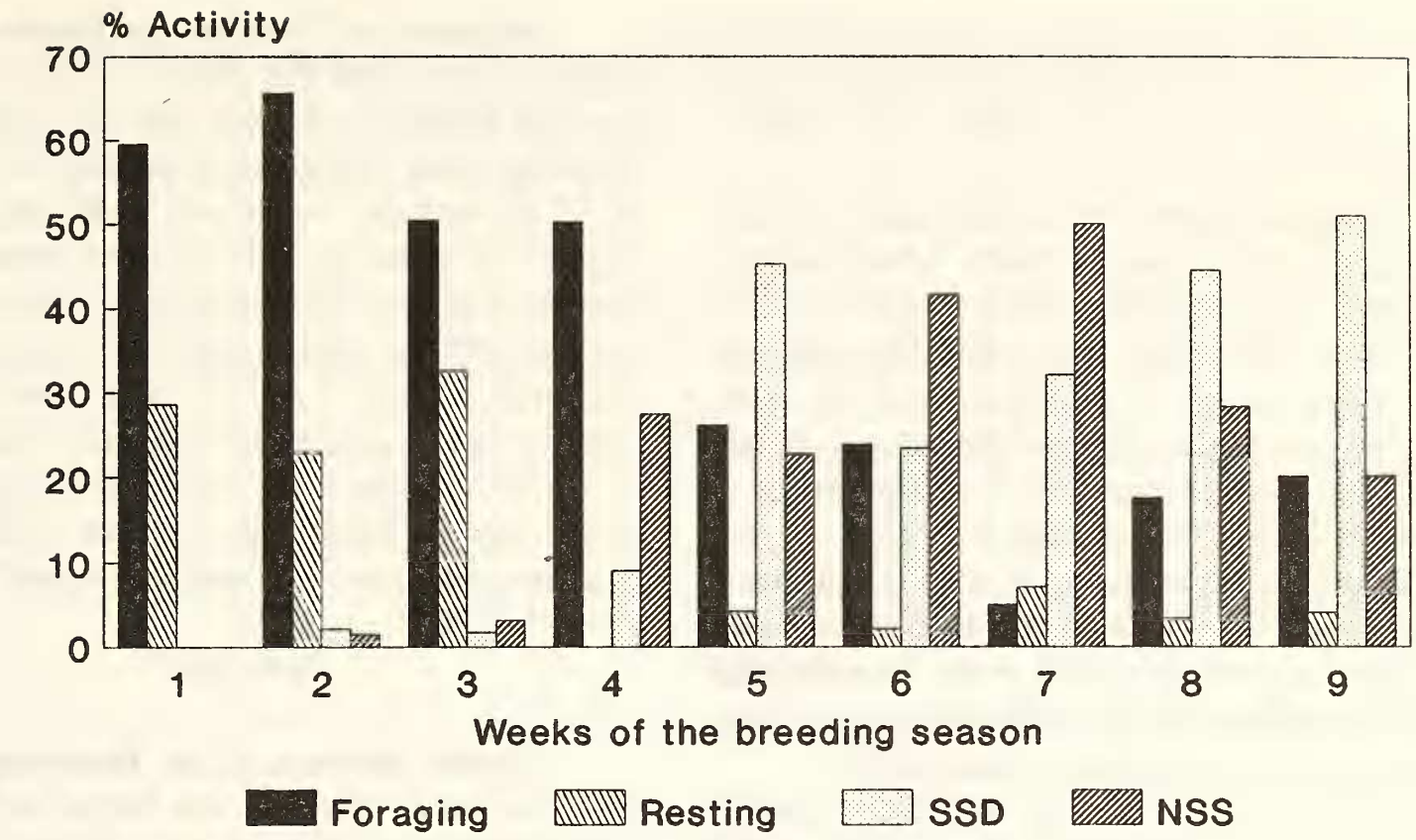
period was brief and NSS phase was very brief. At the Naulakha grassland, however, the entire display patterns, i.e. the pre-territorial period, changing NSS and SSD were prominent and extended as a result of staggered grass growth due to livestock grazing.

Throughout the early and peak territorial periods, male lesser floricans display throughout the day, but more so in the mornings and evenings. This is especially true during cloudy days, when males display with very brief breaks throughout the day. Towards the end of the breeding season, due to an increase in day temperatures and a waning of display intensities, males display almost exclusively in the mornings or evenings. However, even during the waning of the breeding season males tend to display for brief periods in the afternoon.

Change in Display Patterns with Grass Height: When the frequency of spot specific display was regressed against grass height a significant increase in spot specificity was seen with an increase in grass height ($r = 0.889$, $df = 6$, $p<0.01$; Fig. 3a and 3b). At Naulakha grassland, early grazing resulted in lower grass growth rates and net grass heights than in Rampura which was not grazed during the monsoon. Percentage of spot specificity in relation to non-specific display was higher at Rampura than at Naulakha for the same time scale (Fig. 3a and 3b).

When rainfall is below normal, less dense vegetation may result in greater time spent in non-spot specific jumping than spot specificity. Similarly, those males which display from or close to the edge of crop fields are less prone to be spot specific and tend to display from various locations within their territories.

Time lag between jumps: The time lag between two consecutive jumps was significantly shorter when males displayed from a specific



SSD - Spot specific display
NSS - Non-spot specific display

Fig. 2. Changes in display patterns between pre - and peak territorial periods in the lesser florican.

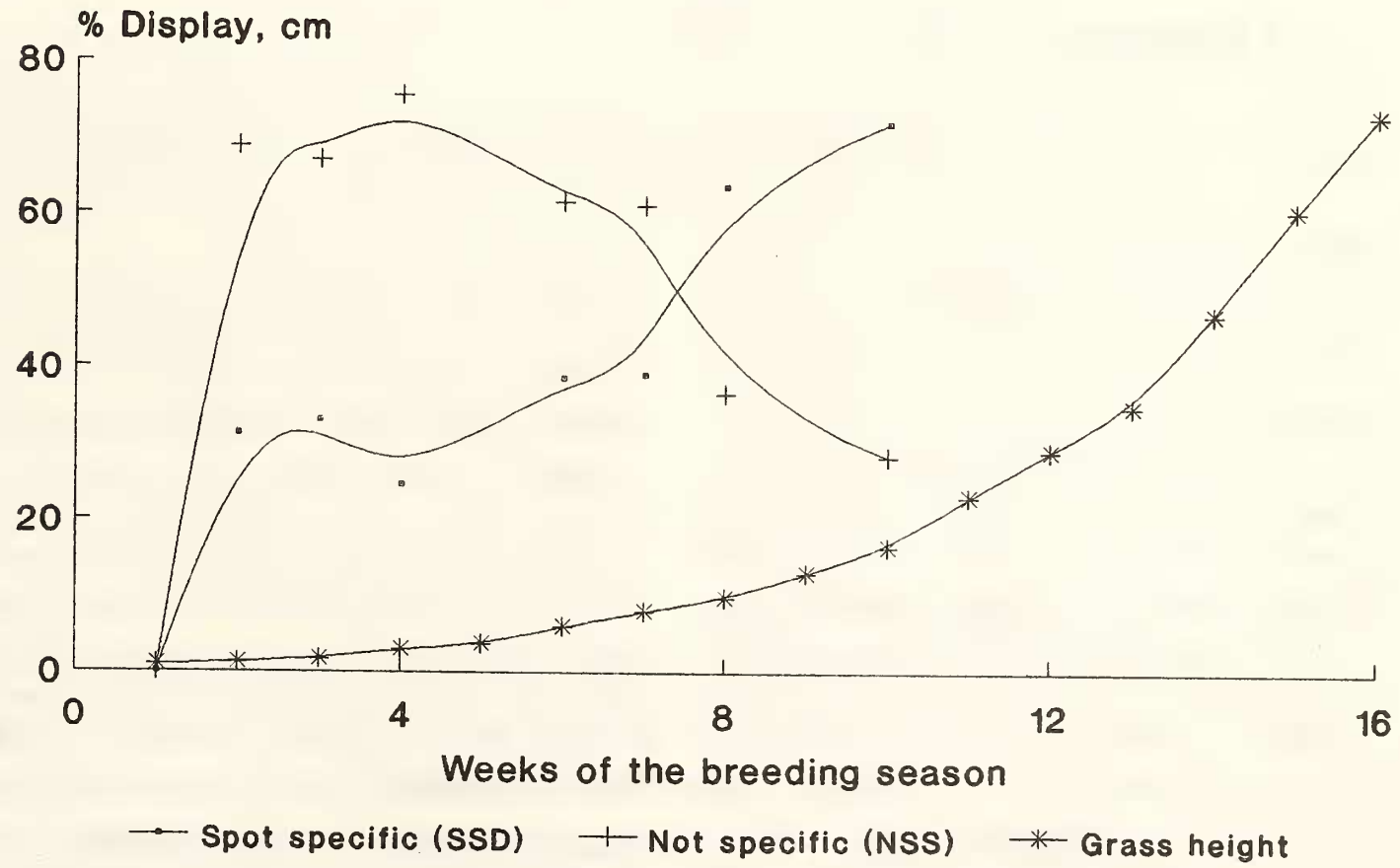


Fig. 3a. Variation in spot specific display with grass height in a grassland grazed in the early monsoon (Naulakha),

spot than when displaying from different spots (T-Test t = 7.100, p < 0.0001; mean SSD = 36.20 seconds, SD = 28.63; mean NSS = 58.13, SD = 62.62).

Jumping Spots: Males increasingly begin using a few locations from which they display. Usually at peak breeding period a male may have two to five such spots. These 'jumping spots' are one to two metres in diameter, with the earth trampled bare of all vegetation. Jumping spots may shift from time to time due to disturbances or excessive growth of vegetation. In areas of long grass, jumping spots are established in patches of shorter grass. In areas of short grass, jumping spots are close to a patch of long grass. In undulating terrain, jumping spots are located at the top of ridges and the ground immediately around is flat.

Fig. 4a and 4b (see pp. 408, 409) represent grass height at 1, 5, 10 and 25 metres along the north, south, east and west axis at four different jumping spots. The jumping spots are centrally located in a 'saucer' where grass height increases from the centre to the periphery.

Influence of Weather on Display Rates: Display rates were the highest under cloudy or overcast conditions. Lower rates of display occur under sunny or partly cloudy conditions (Tables 2 & 3). Under rainy conditions males displayed at highest rates during light drizzles, while strong drizzles and rainy weather caused males to reduce significantly the display rates or to cease displaying totally (Tables 2 & 3). Display rates were the same under all wind speed conditions (Tables 2 & 3). When display rates were correlated against temperature, a significant decrease in the rate of display was seen as temperature increased ($r = -0.52$, $df = 24$, $p<0.02$).

Discussion

Display patterns in the Breeding Season: The onset of territoriality and display in the lesser florican is phased. In the pre-territorial period aerial display in males is an inconsistent activity. The onset of territorial behaviour is characterised by sustained aerial display. Once the males become territorial, the time spent in display does not appear to vary

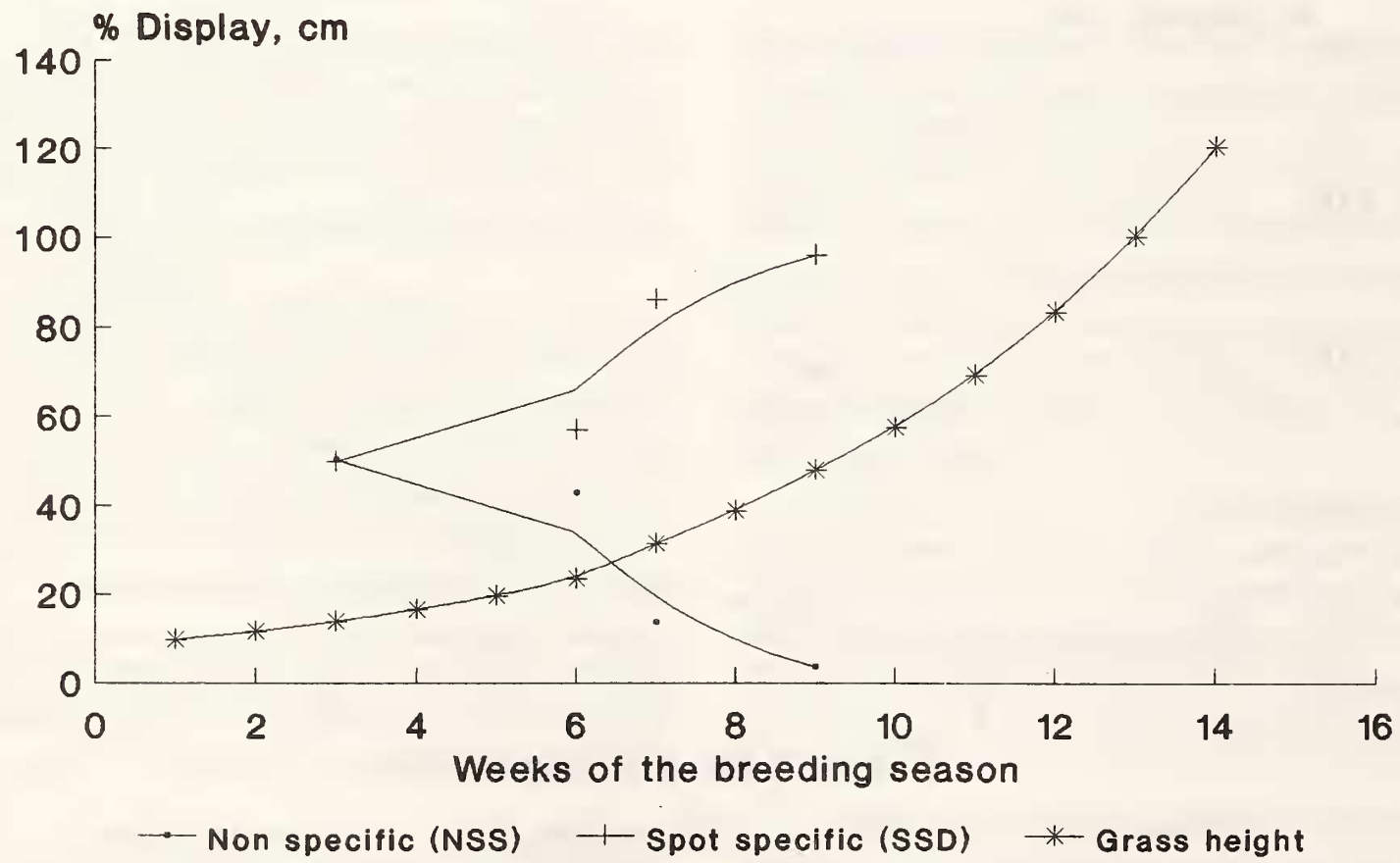


Fig. 3b. Variation in spot specific display with grass height in a grassland not grazed during the monsoon (Rampura).

TABLE 2
BASIC STATISTICS FOR DISPLAY RATES (LEAPS/MINUTE) UNDER DIFFERENT WEATHER CONDITIONS

	W1	W2	W3	W4	R1	R2	R3	R4	B1	B2	B3
N	13	25	27	94	27	11	12	122	70	42	21
Minimum	0	0	0	0	0	0	0	0	0	0	0
Maximum	1.93	2.3	3	3.7	2	1.39	0.14	3.12	3.08	1.93	2.25
Mean	0.75	0.92	1.29	1.39	0.92	0.45	0.02	1.22	1.06	1.14	1.01
SD	0.75	0.79	0.95	0.79	0.57	0.51	0.05	0.8	0.86	0.6	0.65

TABLE 3
EFFECTS OF WEATHER ON DISPLAY RATES (MANN WHITNEY U TEST, DF=1)

Cloud cover	W2		W3		W4	
	U	P	U	P	U	P
W1	144.0	0.57	120.0	0.11	342.0	0.01
W2			264.0	0.18	813.5	0.02
W3					1191.0	0.63
Rain intensity	**R2**		**R3**		**R4**	
	U	P	U	P	U	P
R1	217.5	0.03	296.0	0.01	1265.5	0.06
R2			104.0	0.01	298.5	0.01
R3					98.5	0.01
Wind speed	**B2**		**B3**			
	U	P	U	P		
B1	1347.5	0.46	739.5	0.97		
B2			500.5	0.39		

Key for Tables 4.2. a to 4.4. b
W1 = 0-25% cloud cover; W2 = 25-50% cloud cover; W3 = 50-75% cloud cover;
W 4 = 75-100% cloud cover. B1 = breeze; B2 = moderate wind; B3 = strong wind;
R1 = light drizzle; R2 = strong drizzle; R3 = rain; R4 = No rain or drizzle.

significantly between days. Males spend 70% or more of the day in display activities for most of the territorial phase. Variations in the time spent in display, can be attributed to fluctuations in daily weather conditions. On a predominantly rainy or a hot sunny day, males display less, irrespective of whether they are in the early or peak display phase.

What does vary over the territorial phase is the nature of the display leap, i.e. whether the male moves between leaps or displays from a fixed spot. During the early territorial phase, males move constantly between display leaps. A decrease in such movement between leaps is simultaneous to an increase in spot specific display, until most displays are performed from a few 'jumping spots'. This change can be attributed to different reasons, and the degree of influence of each is yet to be determined.

First, the period of lowest spot specificity coincides with lower availability of food resources. In this period males have to spend more time in foraging over a wider area to fulfil nutritional needs and perhaps to build up a certain amount of energy reserves as well. Dharmakumarsinhji (1950) opined that 'when the birds have newly arrived, when they are in lean condition, they feed at all times of the day.' As the season progresses, insect life becomes considerably more abundant, and individuals would have to spend less and less time to fulfil nutritional requirements.

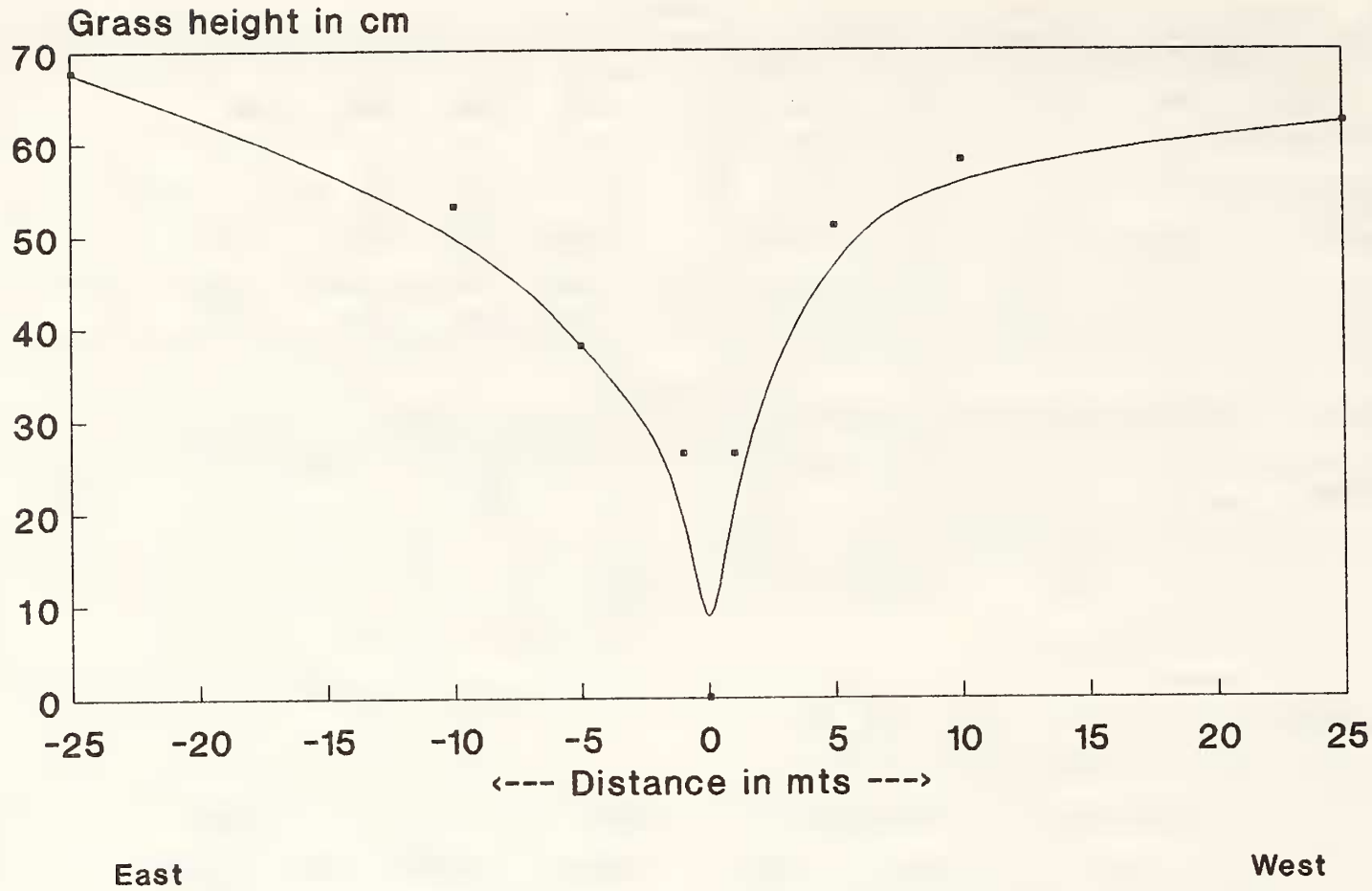


Fig. 4a. Grass height at jumping spots in the lesser florican

The second possibility, the only one which has been directly substantiated, deals with grass height. A strong positive correlation is seen between spot specific display and increasing grass height. This correlation can have three explanations: (a) On arrival of the floricans, the grassland is bare of vegetation. Sustained display at fixed sites, in the absence of sufficient cover, could greatly increase predation risks. Thus with increasing grass cover, males can display with relatively greater safety from fixed sites for longer durations; (b) As insect abundance is directly related to increasing grass height, spot specific display can be concomitant to that of nutritional demands; (c) Non-spot specific display occurs at a time when the grass height is short and free movement is possible. Once the grass grows tall, arbitrary choice of jumping spots will be hampered by the grass. Males may then return to fixed spots as these are trampled bare of vegetation, and are also set in patches of shorter grass. In grasslands where grass grows rapidly taller, as in Rampura, males spend far more time in spot specific display than in grasslands that have shorter net grass heights (Naulakha). In years of lower rainfall and shorter grasses, males tend to spend more time in non-spot specific display, than in years of greater grass heights.

Thirdly, if fitness of a male is advertised by frequency of display and thus enhances mating success, then as the breeding season progresses males should attempt to display at maximum frequencies. (The time lag between leaps was significantly lower in spot specific display than that of non-spot specific display). Thus a peak in display rates should be evident in early to mid-August when females become receptive. Males may achieve this, not by increasing time spent in display but by reducing movement between display which results in an increase in frequency of jumps.

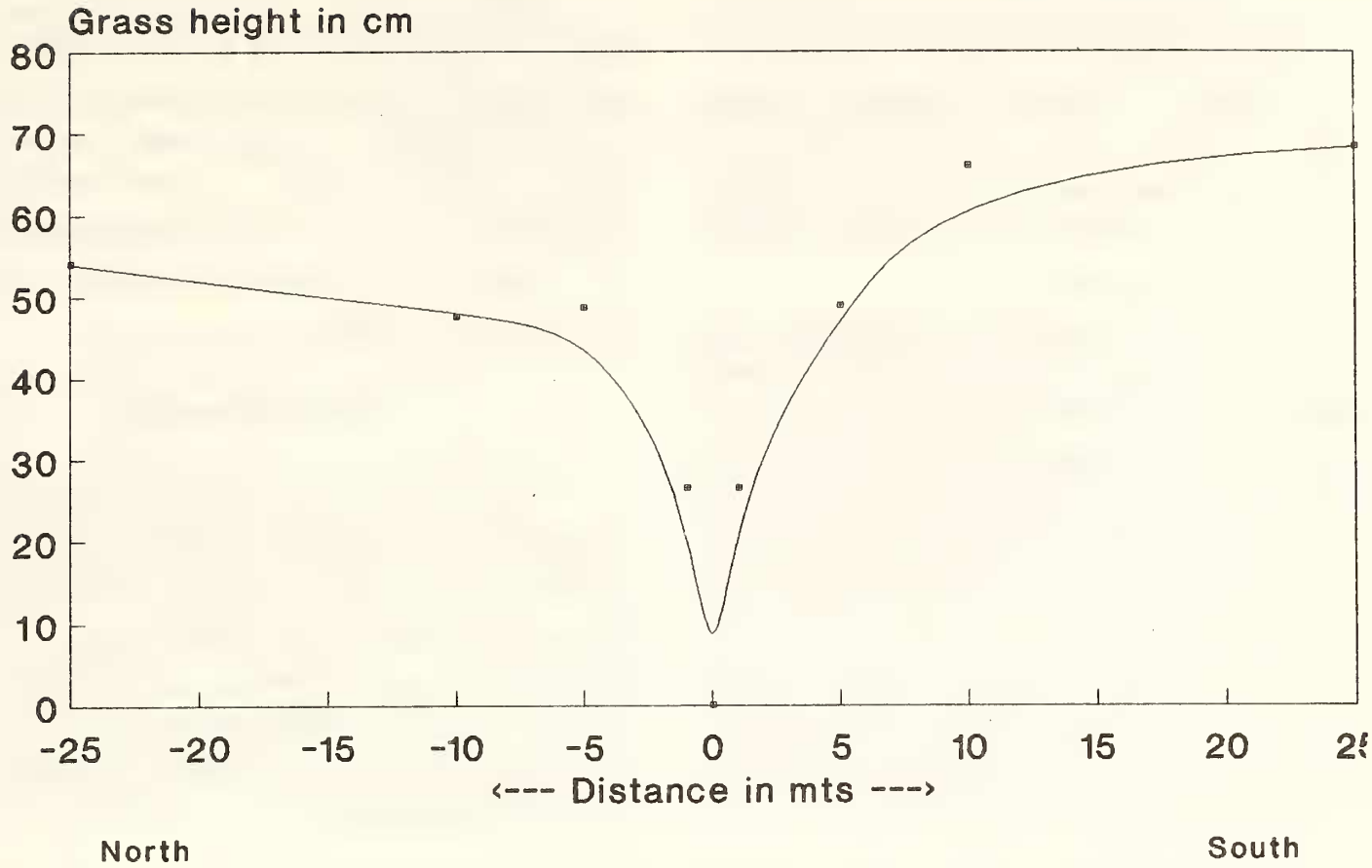


Fig. 4b. Grass height at jumping spots in the lesser florican

Effect of Weather on Display Rates: Several species of birds display mainly at dawn and dusk or at night and include among others the Sage Grouse (Gibson and Bradbury 1987) and the Great Snipe (Avery and Sherwood 1982, Hoglund and Robertson 1990). Other species of birds have been specifically associated with particular types of weather. For instance, the Mistle Thrush and the Red Flanked Blue Tail are both persistent songsters in rain and windy weather, and damp cloudy days with drizzle have been typically associated with the 'reeling' of the Grasshopper Warbler and the drumming display of the snipe. Elkins (1983) suggests that the rather unique sounds of those species associated with inclement weather may carry further under cloudy or overcast conditions.

The display leap of the lesser florican communicates both acoustic and visual signals over longer distances and should logically be performed most frequently during weather conditions that maximize the range of such signals. For instance, audibility is high when an inversion is present and may account for the high levels of bird song on clear calm mornings (Elkins 1983). Similarly, visibility is higher on clear days, and sunshine would better contrast the black and white plumage of the male lesser florican during its display leap. Yet males display at higher rates under overcast conditions when presumably both auditory and visual ranges are reduced. Then again, turbulence during strong winds reduces the audibility of acoustic signals (Elkins 1983), yet there is no significant difference in display rates under different wind speeds. That the leaps of the lesser florican are performed maximally during weather conditions that do not maximize the range over which these signals are communicated is of particular interest.

The frequency of bird song, rather than the audible range, is possibly of greater biological significance (Elkins 1983). For instance, in the Sage

Grouse, 'males that mated attended the lek more often, displayed at higher rates and scored higher on an acoustic component than those that did not mate (Gibson and Bradbury 1985). If display rates are associated with mating success, then males should display for as long a duration and at as high a rate as possible to maximize success.

If display rate is of greater significance in the lesser florican, then males should display at higher rates in those environmental conditions that require the least expenditure of energy, or more important, cause least stress to the individual. A high display rate in hot sunshine should cause thermo-regulatory stress on the individual. This is also indicated by the inverse correlation between display rates and temperature. Hence males display at higher rates in cloudy conditions, when heat stress must be least, than in sunny conditions when heat stress should be most (see also Ridley *et al.* 1985).

Under strong windy conditions, a male displaying as close as 50 m or less down wind is often inaudible to the human observer. Conversely, a bird displaying in strong up wind can be heard as much as 500 m away or more. Perhaps such compensation in open country result in the absence of a significant variation in display rates under different wind speeds.

Acknowledgements

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